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PUBLIC WATER SUPPLIES IN ILLINOIS¹

BY HARRY F. FERGUSON²

A good public water supply is the most important public improvement in any municipality. By good water supply is meant a supply that at all times is adequate, clear, of reasonably satisfactory mineral quality for all domestic uses, and especially of safe sanitary quality. Any public improvement is made for the convenience or comfort that it will provide. Paved streets, electric lights, municipal buildings, provide convenience and comfort, but a public water supply not only provides these but also improves health and sanitary conditions. Paved streets, electric lights, good public buildings are desirable, but a municipality might struggle along without them. Without a city's water supply, however, within a few hours serious health conditions would exist and a fire might wipe out the entire community.

The Illinois State Department of Public Health, since the creation of the Division of Engineering and Sanitation in 1915, has been making careful examinations of all public water supplies and has been coöperating with city officials, civic organizations, waterworks officials, engineers, and others interested in the improvement of existing unsatisfactory water supplies, and in the installation of new water supplies. Detailed reports are prepared on the basis of each examination, copies of which are placed in the hands of the persons responsible for the operation of the waterworks or the installation of the new public water supply.

Public water supplies have been installed in 449 municipalities. In addition records have been obtained of the public water supplies at 10 unincorporated communities, at the 28 State institutions and the 7 Federal institutions, army posts, and naval stations in the State, making 494 in all.

Before presenting the history of the development of public water supplies in Illinois and the present situation relative to public water

¹ Read at annual meeting of Illinois Section, Champaign, March 29-30, 1922.

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supplies, certain statistics relative to the State should be considered. Illinois was admitted into the Union in 1818 as the twenty-first State. The State has an area of 56,043 square miles and is divided into 102 counties. The population in 1920 was 6,485,280 which represents an increase of 15 per cent since 1910. The increase for the same period for the entire United States was 14.9 per cent, and thus Illinois is having an average growth as compared to the entire United States. Forty-six of the 102 counties increased and the other counties decreased in population in the decade 1910-1920.

The increase in population has been greater in proportion in municipalities than in the rural districts, which means that, even if no new public water supplies were installed, the proportion of the population served by public water supplies would be increasing at a slightly faster rate than the total population, assuming distribution systems are extended to serve the increased populations in cities. The Federal census shows that for the past three decades the proportion of the population in Illinois in municipalities of 2,500 and over was 54.3 per cent, 61.7 per cent, and 67.9 per cent. Municipalities of even less than 2,500 should be considered as urban instead of rural, as defined in the Federal census reports. Especially is this true when considering public water supplies, for under ordinary conditions a community having a population of only 300 or perhaps less might well have public water-supply installations, as well as other public improvements.

Ordinarily the term "public water supply" is applied to a supply serving a community, whether or not such a community is incorporated, but in the remainder of this paper the term will be limited to supplies for incorporated communities. The 10 unincorporated communities having public supplies and the State and Federal institutions will be omitted. According to the 1920 Federal census the total number of public water supplies, for incorporated communities, that would be possible in Illinois is 1,111 for there is that number of municipalities, of which 259 are incorporated as cities, 31 as towns, and 821 as villages. The development of incorporated areas (municipalities) in Illinois is presented in figure 1, which shows the number of municipalities incorporated each year. The diagram shows a fairly uniform rate of increase in the number of municipalities from about 1850 until near 1910 from which time the rate of increase has been slower.

The distribution of population among the municipalities of different sizes is presented in table 1. This table shows that Chicago has about two-fifths of the entire population of the State, that 939

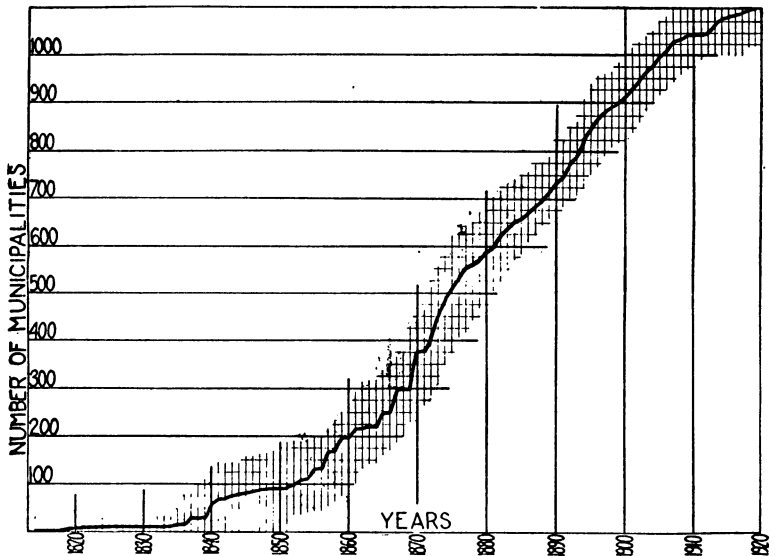


FIG. 1. DEVELOPMENT OF MUNICIPALITIES IN ILLINOIS

TABLE 1

Distribution of population among municipalities

POPULATION CLASSIFICATION	NUMBER OF MUNICIPALITIES	POPULATION	PER CENT OF TOTAL POPULATION
1,000,000 or more	1	2,701,705	41.5
50,000-100,000	4	267,722	4.1
25,000-50,000	12	432,588	6.7
10,000-25,000	27	406,143	6.3
5,000-10,000	47	324,046	5.0
2,500-5,000	81	273,474	4.2
Less than 2,500	939	678,312	10.5
Unincorporated areas		1,401,290	21.6
Entire state	1,111	6,485,280	100.0

of the total of 1,111 municipalities, or 84 per cent, have only one-tenth of the population, that about one-fifth of the population lives in unincorporated areas, and that the remaining three-tenths

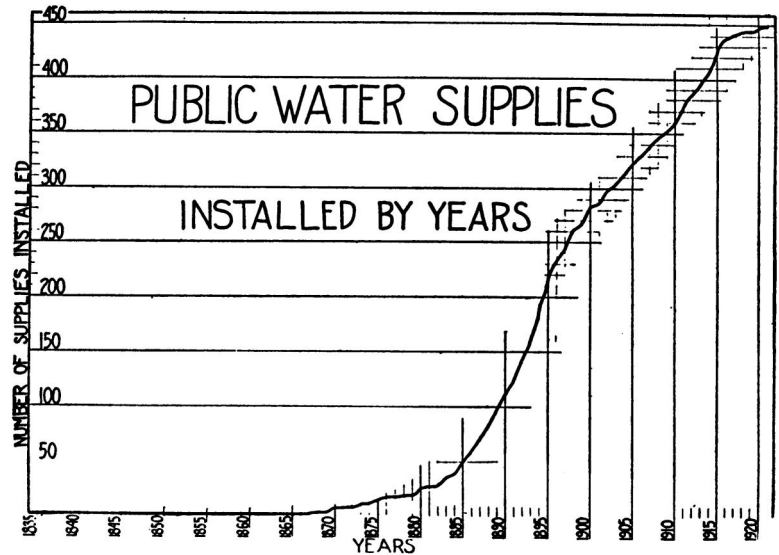


FIG. 2. PUBLIC WATER SUPPLIES INSTALLED BY YEARS IN MUNICIPALITIES IN ILLINOIS

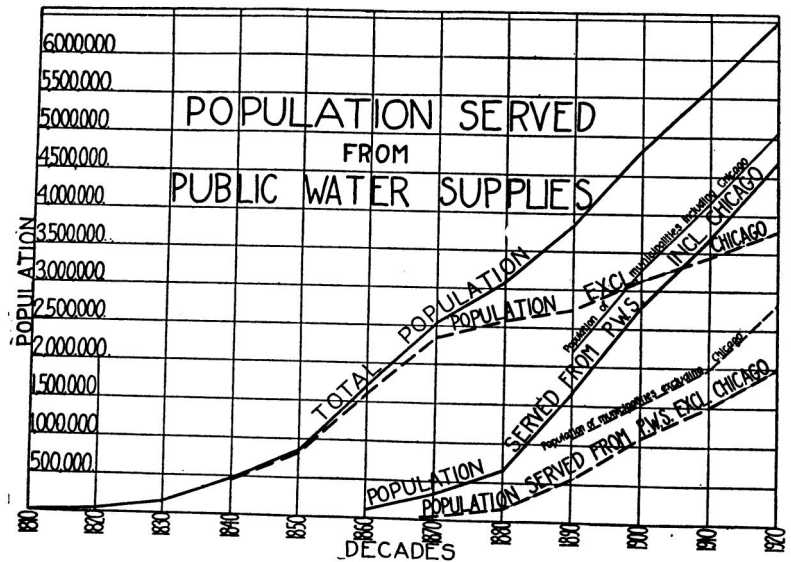


FIG. 3. POPULATION SERVED FROM PUBLIC WATER SUPPLIES IN ILLINOIS

of the population are distributed comparatively evenly among five groupings of municipalities by population.

The number of public water supplies that have been installed in municipalities in Illinois and the rate of such development are presented in figure 2. The diagram shows a fairly uniform and rapid rate of increase in the number of supplies, beginning about 1885 and continuing until about 1916. The decrease in rate beginning with 1916 probably is the result of war conditions.

Figure 3 gives population curves for the entire State and for the State excluding Chicago, as recorded in the Federal census reports, and also curves showing the population served by public water supplies. This diagram indicates that following about 1885 the popula-

TABLE 2
Population served by public water supplies by decades

YEAR	POPULATION		POPULATION SERVED BY PUBLIC SUPPLIES	
	Entire State	Excluding Chicago	Entire State	Excluding Chicago
1840	476, 183	471, 713	4, 470	0
1850	851, 470	821, 507	29, 963	0
1860	1, 711, 951	1, 602, 691	109, 260	0
1870	2, 539, 891	2, 240, 914	339, 190	40, 213
1880	3, 077, 871	2, 574, 686	662, 882	159, 697
1890	3, 826, 352	2, 726, 502	1, 660, 327	560, 577
1900	4, 821, 550	3, 122, 975	2, 797, 690	1, 099, 115
1910	5, 638, 591	3, 453, 308	3, 696, 751	1, 511, 468
1920	6, 485, 280	3, 783, 575	4, 696, 381	1, 994, 676

tion served by public water supplies has increased at a slightly more rapid rate than has the total population. This is true for the entire State and for the State excluding Chicago, and has been the result of the increase in the number of public water supplies and also of the greater proportionate increase in population in municipalities as compared with the population increase in rural areas. This diagram also presents visually the fact that, because of the high rate of increase in population for Chicago, the rate of increase for the entire State has been higher than the rate of increase for the State excluding Chicago.

Public water supplies in Illinois may be divided into three general classes; (1) those obtained from surface sources, (2) from drift wells, and (3) from rock wells. There are, in addition, sources such

as springs and abandoned mine shafts or workings, but supplies from such sources may be classified with the drift or rock well supplies, depending upon the formation from which the waters are derived. In general, the supplies for the northern portion of Illinois are obtained from rock wells and most of these wells penetrate St. Peter or Potsdam sandstone. The majority of the supplies for the central portion of Illinois are obtained from sand and gravel forming part of the glacial-drift deposits. Nearly all of the supplies for the southern portion of Illinois are derived from surface sources, for in that section supplies from wells would be either inadequate or so highly mineralized as to be unsatisfactory for general domestic purposes.

TABLE 3

Number of public water supplies classified by source and population served by each classified source

SOURCE OF SUPPLY*	NUMBER OF PUBLIC SUPPLIES	POPULATION SERVED 1920
Surface water.....	95	3,541,440
Drift wells.....	159	515,640
Rock wells.....	195	639,301
Total.....	449	4,696,381

* There are 8 municipalities, having a total population of 57,404, that have combined rock well and surface supplies; 4 municipalities, having a total population of 29,029, that have combined drift well and surface supplies; and 10 municipalities, having a total population of 65,687, that have combined rock and drift well supplies. Each of these 22 places have been included in one of the three classified groups in accordance with which source of supply constitutes the major source of the total water used.

Table 3 presents the number of public supplies obtained from the three classified sources and the population (1920 Federal census) served by such supplies.

This table shows that, although only one-fifth of all the public supplies have surface-water sources, these surface supplies serve about three-fourths of the entire population served by all public water supplies. This is, of course, because the large population of Chicago, served by Lake Michigan water, and also the municipalities north, south, and a few to the west of Chicago, that are also served by Lake Michigan water, influence this relationship. There are slightly more rock-well than drift-well supplies, but the average population served per supply is about the same, namely, about 3,000.

Table 4 analyzes the distribution of population served by public water supplies as regards classified sources.

This table shows that 92.5 per cent of the population of all incorporated communities are served by public water supplies. Since only 449 of the 1,111 incorporated communities have public water supplies, more than doubling the number of public water supplies would increase the population served by public supplies less than 10 per cent.

TABLE 4

Total populations and percentages of population served by classified sources of public water supplies

POPULATION-SOURCE CLASSIFICATION	POPULATION AND PER CENTS	
	Including Chicago	Excluding Chicago
Population of all municipalities in State.....	5,083,990	2,382,285
Population served by public water supplies.....	4,696,381	1,994,676
Per cent of population in all municipalities that are served by public water supplies.....	92.5	83.5
Population served by surface supplies.....	3,541,440	839,735
Per cent of population served by public water supplies that are served by surface supplies.....	75.4	42.1
Population served by drift-well supplies.....	515,640	515,640
Per cent of population served by public water supplies that are served by drift-well supplies.....	11.0	25.9
Population served by rock-well supplies.....	639,301	639,301
Per cent of population served by public water supplies that are served by rock-well supplies.....	13.6	32.0

The distribution of the municipalities that do not have public water supplies is presented in Table 5 according to population groups. The largest municipality that does not have a public water supply is Zion City (1920 Federal census 5,580). There are more municipalities having populations of over 300, that do not have public water supplies, than there are municipalities that have already installed such supplies, but the total population not served is comparatively small. Installing public water supplies in the 89 cities having populations of 1,000 or more, which do not have public water supplies, would reduce the total population of municipalities not now served by public water supplies by one-third.

A large number of new public water supplies should be installed in Illinois, but the magnitude of such installations will be small in

comparison to installations already made. In addition to the new supplies that should be installed there remains a large amount of development to be done before many of the existing public water supplies in Illinois may be considered to be satisfactory from the standpoint of domestic service, fire protection, and health and sanitary conditions. Additions and improvements to these existing supplies probably will require considerably more work and expenditures than the installation of supplies in the municipalities now without public water supplies.

TABLE 5
Number of municipalities that do not have public water supplies
Arranged by population groups

POPULATION GROUP	NUMBER OF MUNICIPALITIES WITHOUT PUBLIC WATER SUPPLIES		POPULATION FOR EACH GROUP	TOTAL POPULATION
	For group	Total		
5,000 up	1	1	5,580	5,580
3,000 to 5,000	7	8	26,190	31,770
2,000 to 3,000	9	17	21,896	53,666
1,500 to 2,000	16	33	27,225	80,891
1,000 to 1,500	56	89	68,005	148,896
750 to 1,000	64	153	55,481	204,377
500 to 750	120	273	72,005	276,382
400 to 500	91	364	41,047	317,429
300 to 400	109	473	38,126	355,555
Under 300	189	662	32,054	387,609

In discussing the population served by public water supplies, the total population of each municipality has been considered as served, but in reality there are a number of municipalities where only a portion of the population actually uses the public supplies and there are some where only a few people really use the supply. This limited use of many public water supplies is due to limited extensions of mains in some municipalities, the inadequacy of supplies in others, and the unsatisfactory quality of the supplies for domestic purposes in municipalities where the supplies are scarcely used, except for fire protection.

The inadequacy of supplies in some municipalities is the result of increases in populations, in others of the decreased yields of the sources, and, in some instances, the supplies have never been adequate for more than part of the populations and, as the number of

service connections increased, the inadequacy of such supplies has been locally realized. With few exceptions, where the supplies are of unsatisfactory quality they have been so since their installation.

The enlargement and improvement of existing public water supplies, combined with the installation of supplies in municipalities as yet without them, represent a large amount of work for engineers and others interested in water-supply development, even though the population of the State does not increase. With the increase expected in population of the State and the noticeable increasing desire of the people for better and more adequate water supplies, the development work to be done becomes great.

The minimum size of community that should have a public water-supply system may not be definitely stated. Communities of even a few dwellings, in those areas in Illinois where water is obtainable from rock or drift wells at comparatively low cost, might to the advantage of all property owners have public water-supply systems. The installation and operation costs of a single pumping outfit would be less than the cost for several private running-water-supply installations. This saving would tend to offset the cost of a distribution system and the remaining cost of the distribution system would be cheap fire and health insurance. It must be remembered, also, that a public water supply gives greater convenience and comfort, makes possible the better keeping of lawns, and improves the civic appearance of the community.

Communities in those areas in Illinois where surface supplies must be developed for public use have more expensive problems to meet and the smaller municipalities are at a disadvantage. For instance, in the southern portion of Illinois where practically all public supplies must be obtained from surface sources, the costs of such developments are much higher than for wells in central or northern Illinois. To develop a satisfactory surface supply requires a filter plant, and unless the municipality is on a stream having an adequate daily flow a dam and impounding reservoir must be constructed at considerable expense. It is frequently the case, also, that a suitable dam site can be obtained only at considerable distance from the municipality, which means a long force main and the hauling of coal to a pumping station at the reservoir or an electric transmission line. In urging communities to install public water supplies and otherwise helping to bring about such installations, efforts are not, therefore, necessarily concentrated on the larger municipalities as yet without such supplies.

An essential part of the examinations of public water supplies made by the Division of Engineering and Sanitation of the State Department of Public Health relates to their sanitary quality and adequacy. The adequacy of a supply affects the health and sanitary conditions in a community, though not as much, of course, as the quality. This has been evident in some communities where supplies have proved inadequate during the summer months of dry years. As a result insanitary conditions were created because of the curtailed use of plumbing and sewerage installations or people have resorted to the use of insanitary private wells. In one instance a hospital, where a number of patients were confined, had difficulty in obtaining water because of water shortage and decreased pressure.

A bad water supply is probably more dangerous to the public health than no public water supply, for in the absence of a public supply it is not likely that many wells would be contaminated at the same time, and thus only occasional cases of water-borne disease would prevail. But with a bad public water supply the whole community might be involved in a serious epidemic, and this has been actually the case in several municipalities in Illinois.

The studies made relative to the sanitary quality of water supplies include examinations of the sources of the supplies and the methods of handling the waters, as well as analyses of samples. This includes, of course, in the case of surface supplies the operation of water-purification plants or simply the sterilization of such supplies by liquid chlorine or hypochlorite if filters have not been installed. The water-purification plants in Illinois, their operation, and analytical control will be presented in a separate paper to be read at this meeting by Mr. Cowles, assistant sanitary engineer, of the department. In determining the sanitary quality of water supplies as delivered to consumers, consideration must be given also to the supplies even after pumped into the distribution systems, for cross connections between a public water supply of good quality as delivered to the mains and a polluted private or industrial supply may result in dangerous contamination of the public supply. In Illinois, within the past decade, two epidemics, each involving more than 200 cases of typhoid fever and over 15 deaths, as well as several smaller epidemics, have occurred because of the pollution of good water through cross connections with impure supplies.

Of the 449 water supplies in municipalities and the 10 supplies in unincorporated communities, 339, or 74 per cent, have been

classified as of good sanitary quality, 86, or 19 per cent, as doubtful, and 34, or 7 per cent, as bad. Of the water supplies at the 28 State institutions, the sanitary quality of 20 may be classed as good, of 7 as doubtful, and of 1 as bad. The water supplies at the 7 Federal institutions are all of good sanitary quality.

When the Department classifies a water supply as of good sanitary quality it means that analyses have shown that it was of satisfactory sanitary quality at the time samples were collected and careful inspection of the waterworks system indicated that the supply was not subject to contamination at the source, or in the handling and distribution. The "Doubtful" supplies are those supplies that show satisfactory results by analyses, yet inspections have shown that there are certain possibilities of contamination, though such possibilities are slight. "Bad" supplies are those supplies that are undoubtedly contaminated, such as surface supplies without treatment or which the physical examinations show are subject to fairly certain pollution. In a number of instances slight modification at the waterworks would make doubtful supplies satisfactory, and in other instances rather extensive improvements would be necessary.

All the public water supplies and the supplies at State institutions and Federal institutions and camps in Illinois are listed in a special bulletin issued by the Department, which bulletin is obtainable upon request. In it are recorded the population for each community, source of public water supply and its treatment, if any, and the sanitary quality of each supply.

The sanitary quality of a water supply is, of course, subject to change if improvements are made, and the department is always glad to learn at any time of any improvements, so that reinspections may be made and the recorded quality revised, if necessary, so that records of the department may be as complete and accurate as possible. Public distribution of the tabulation and classification of the public water supplies as regards sanitary quality has been helpful in bringing about improvements, for the department does not have authority at present to require doubtful or bad supplies to be made safe, but municipalities and especially chambers of commerce have disliked the unfavorable publicity and have been prompted, in several instances, to improve their water supplies.